

FABE 3130

Heat and Mass Transfer in Food, Agricultural and Biological Engineering

Winter Semester, 2020

Lecture	M,W	705 - 825 pm	Room 100 FABE
Recitation	Th	8 - 950 am	Room 104 FABE
	Th	1020 am - 1210 pm	Room 104 FABE
	Th	355 pm – 545 pm	Room 104 FABE
	F	8 - 950 am	Room 100 FABE
	F	1005 – 1155 am	Room 247 AA

Course Objectives –

- To understand fundamental concepts of heat and mass transfer as applied to food, agricultural and biological systems.
- To develop and apply mathematical expressions associated with steady and unsteady state heat and mass transfer.
- To gain experience in solving problems requiring application of heat and mass transfer concepts.
- To explore the unique applications of heat and mass in food, agricultural and biological systems.

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Office Hours: M: 4-5 pm; Tu: 1-3 pm; W: 3-4 pm

Teaching Assistant: Jacquelyn Blanchard, Graduate Teaching Assistant

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Office Hours: Wednesday: 12 – 2 pm

Teaching Assistant: Nikita Khozin, Graduate Teaching Assistant

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Office Hours: Monday: 12 – 1pm, Thursday: 9 – 10 am

Text Book:

Cengel, Y.A. and A.J. Ghajar. 2020. *Heat and Mass Transfer; Fundamentals & Applications*. 6th Ed. The McGraw-Hill Book Co, Inc. New York.

For this course, students must purchase McGraw-Hill Education Connect for access for the 6th edition of Heat and Mass Transfer by Cengel and Ghajar. Connect will provide full access to the eBook, so a print text is not required. If students purchase a used textbook, Connect access must still be purchased. Power point directions and/or video are provided on Canvas as a guide to the Connect registration process. If students encounter difficulties with Connect registration, contact the McGraw-Hill Technical Support Team.

Reference Books:

Geankoplis, C.J. 2003. *Transport Processes and Separation Process Principles*. 4th Ed. Prentice-Hall. Upper Saddle River, NJ.

Datta, A.K. 2002. *Biological and Bioenvironmental Heat and Mass Transfer*. CRC Press. Boca Raton, FL.

Lecture/Recitation Schedule

<u>Date</u>	<u>Topic</u>	<u>Reading</u>
1/6	Introduction to course; Review of thermodynamics	Sec 1.1-1.5
1/8	Heat transfer modes; conduction, convection, radiation.	Sec 1.6-1.9
1/9-10	Quiz; Mechanical refrigeration applications (virtual)	Sec 1.12-1.13
1/13	Heat conduction equations; steady vs. unsteady-state	Sec. 2.1-2.3
1/15	Heat conduction; boundary conditions, solutions	Sec. 2.4-2.5
1/16-19	Quiz; Thermo-physical properties (virtual)	pp 123-128
1/20	Holiday	
1/22	Steady-state conduction; wall sections	Sec.3.1-3.3
1/23-24	Quiz; Plate Heat Exchangers (laboratory)	
1/27	Steady-state conduction; cylinders, spheres	Sec.3.4-3.5
1/29	Unsteady-state heat conduction; lumped parameters	Sec.4.1-4.2

1/30-31 Quiz; Heat transfer in biological tissue (virtual)	Sec 3.7
2/3 Unsteady-state heat conduction; charts, applications	Sec.4.3-4.4
2/5 Numerical methods; Introduction	Sec.5.1-5.3
2/6-7 Quiz; Examination #1 Review	
2/10 Examination #1	
2/12 Numerical methods; Two-dimensional; Unsteady-state	Sec.5.4-5.5
2/13-14 Quiz; Overall heat transfer coefficients (virtual)	
2/17 Convection heat transfer; Introduction	Sec.6.1-6.4
2/19 Convection; Solution to equations	Sec.6.5-6.8
2/20-21 Quiz; Heating/Cooling of Objects (laboratory)	pp 283-294
2/24 Convection; Momentum transfer analogies	Sec.6.9-6.11
2/26 Forced convection; External applications	Sec.7.1-7.3
2/27-28 Quiz; Examination #2 Review	
3/2 Examination #2	
3/4 Forced convection; Internal applications	Sec.8.1-8.4
3/5-6 Quiz; Convective heat transfer coefficients (virtual)	
Spring Break (3/9 – 3/13)	
3/16 Forced convection; pipes and tubes	Sec.8.5-8.6
3/18 Natural convection	Sec.9.1-9.3
3/19-20 Quiz; Heating/cooling of liquids (virtual)	
3/23 Heat exchangers; coefficients	Sec.11.1-11.3
3/25 Heat exchangers; applications	Sec.11.4-11.6
3/26-27 Quiz; Examination #3 Review	

3/30 Examination #3

4/1 Steady-state Mass Transfer Sec.14.1-14.2

4/2-4/3 Quiz; Diffusion through films (laboratory)

4/6 Unsteady-state mass transfer; coefficients Sec.14.3-14.4

4/8 One-dimensional mass transfer Sec.14.5-14.6

4/9-10 Quiz; Evaporation from a water surface (laboratory)

4/13 Transient-state mass transfer Sec.14.7-14.8

4/15 Mass transfer coefficients Sec 14.9

4/16-17 Quiz; Moisture diffusion during rehydration (virtual)

4/20 Final Examination Review Sec.14.10

Final Examination –

Monday, April 27; 8-945 pm

Lecture sessions: lecture sessions will be devoted to discussion of reading assignments and solution of example problems. Students should read and study assignments in advance of lecture sessions and be prepared to participate in discussions and to solution of example problems.

Homework Problems: assignments are on a weekly basis and are due on the Monday following the week of the assignment.

Quiz: a 15-min quiz is scheduled to begin each recitation period. The topics on the quiz will be extracted from material discussed during the two previous lecture period. The two lowest quiz scores will be dropped when computing final grades.

Recitation sessions: recitations periods will be used in three ways:

- (1) A 15-min quiz
- (2) A discussion of problems from current homework assignments
- (3) Complete virtual experiments as student teams
- (4) Collect and analyze data from laboratory experiments, as part of a student team.

The topics for the virtual and laboratory experiments are presented in the outline of class sessions. There are eleven different experiments involving collection and analysis of data by students. Each student presents and submits a report based on the data and analysis completed by teams during the recitation/laboratory period.

Grading:

Homework Problems (14)	14%
Quiz (14)	14
Short reports from virtual experiments (7)	14
Formal reports from laboratory experiments (4)	12
Examinations (3)	30
Final Examination	16

93-100	A	73-76	C
90-92	A-	70-72	C-
87-89	B+	67-69	D+
83-86	B	63-66	D
80-82	B-	60-62	D-
77-79	C+	< 60	E

Note – If an overall weighted average of 93% or higher has been achieved by the time of the final examination, students have the option of waiving the final examination.

Academic Honesty:

Academic honesty requires that each student complete all assignments and related work on an independent basis. Students must protect their integrity by being honest in all intellectual endeavors. Proper credit for all information used in an assignment is critical, and the written report or

summary must include the citation for any book, magazine, newspaper or web site used in the completion of the assignment.

Collaboration is expected and encouraged. All reports from independent projects must represent independent work by the student.

Academic misconduct will not be tolerated. Suspected academic misconduct will be referred automatically to the Committee on Academic Misconduct as required by Faculty Rules.

Academic misconduct is defined in the Code of the Student Conduct (3335-23-04, http://jstudentaffairs.osu.edu/info_for_students/jcsc.asp) and the Rules of the University Faculty (3335-31-02, <http://jwww.acs.ohio-state.edu/offices/assjproceduresj1.0.html>)

Disability Services:

Any student who may need an accommodation based on the impact of a disability should contact the course instructor to discuss specific needs. The Office for Disability Services assists faculty in verifying the need for accommodations and developing accommodation strategies. If you have not done so, you are encouraged to contact the Office for Disability Services at 614-292-3307 in room 150 Pomerene Hall to register your disability.

Diversity:

The Ohio State University affirms the importance and value of diversity in the student body. Our programs and curricula reflect our multicultural society and global economy and seek to provide opportunities for students to learn more about persons who are different from them. We are committed to maintaining a community that recognizes and values the inherent worth and dignity of every person; fosters sensitivity, understanding, and mutual respect among each member of our community; and encourages each individual to strive to reach his or her own potential. Discrimination against any individual based upon protected status, which is defined as age, color, disability, gender identity or expression, national origin, race, religion, sex, sexual orientation, or veteran status, is prohibited.